JOURNAL OF THE NATIONAL MEDICAL ASSOCIATION
Vol. 67 March, 1975 No. 2

Original Communications

Lifelong Differences in Hemoglobin Levels Between Blacks and Whites*

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In the course of examining anthropometric and biochemical data, from the Michigan phase of the Ten-State Nutrition Survey of 1968-1970, we encountered a relatively large and systematic black-white difference in hemoglobin levels. Analyzed age by age, from the first year of life through the 9th decade, blacks proved systematically lower than whites by approximately 1gm/100ml.

We therefore maintained a close watch on hemoglobin levels from other states, North and South, East and West, and including New York City. We further reviewed hemoglobin data on tapes from the Pre-School Nutrition Survey, we compared data for blacks and whites from other surveys, and initiated studies that might explain the nature of the hemoglobin differences we had found.

Our question was whether we had uncovered a basic difference in hemoglobin levels, of genetic importance, or an equally-major difference of nutritional concern. The present paper summarizes what we have done, what we have found, and what our conclusions are after five years of investigation.

METHODS AND MATERIALS

This study is based on hemoglobin values from the Ten-State Nutrition Survey of 1968-1970, and involving ten states and New York City. Included and set forth on a geographical basis were Massachusetts, New York (and New York City), Michigan, Kentucky, West Virginia, South Carolina, Louisiana, Texas, California and Washington State. In these 11 locations, hemoglobins and hematocrits were determined by separate central laboratories. The sample was, by definition, lower-income, but included individuals and families ranging through median per-capita income for 1968-1970.[1]

In our data analysis, we used 24 age intervals from age 1 through the 9th decade, to obviate age-differences. We calculated hemoglobins and hematocrits as median values, to eliminate possible skewness. Other information included family income, per-capita income, income relative to needs and information on nutrient intakes and serum and urinary vitamin levels.

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TABLE 1. BLACK-WHITE COMPARISONS IN HEMOGLOBIN LEVELS*

	Males				*Females*			
	Black		*White*		*Black*		*White*	
Age	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*
1	97	10.7	64	11.1	83	10.1	64	11.7
2	114	10.8	81	12.0	140	10.8	96	11.9
3	155	11.4	130	12.0	132	11.4	96	11.9
4	199	11.4	142	12.2	158	11.8	142	12.3
5	198	11.4	190	12.5	206	11.5	161	12.4
6	237	11.6	217	12.5	217	11.8	205	12.4
7	222	11.8	272	12.6	278	11.8	231	12.7
8	221	11.8	272	12.8	241	11.8	229	12.8
9	260	12.0	263	12.8	257	11.8	250	12.9
10	227	12.1	286	13.0	258	12.0	253	12.8
11	222	12.1	272	13.1	264	12.1	250	13.0
12	261	12.1	270	13.3	253	12.1	238	13.0
13	222	12.5	251	13.4	251	12.1	212	13.3
14	215	12.8	198	13.9	224	12.1	175	13.3
15	188	13.1	172	14.2	201	12.2	174	13.3
16	159	13.6	764	14.6	197	12.1	163	13.4
17	110	13.8	137	14.9	138	12.3	138	13.5
20	269	14.5	518	15.3	577	12.5	779	13.4
30	210	14.2	665	15.2	705	12.5	1125	13.4
40	224	14.2	605	15.1	671	12.5	899	13.5
50	241	14.1	610	15.2	593	12.7	900	13.5
60	277	13.8	575	14.9	481	12.8	757	13.8
70	196	13.4	502	14.8	324	12.5	694	13.8
80	78	13.0	240	14.4	112	12.3	306	13.3
Mean Difference		-1.0gm/100ml				-1.0 gm/100ml		

* Bases on 27,397 participants in the Ten-State Nutrition Survey of 1968-1970. Values given above refer to median hemoglobin levels expressed as gm/100ml.

Thus we were able to match for income and per-capita income, as necessary, nutrient-intake and serum and urinary vitamins. In all, nearly 30,000 individuals were represented.

We also had access to the data tapes from the Pre-School Nutrition Survey, a National-Probability Study, with a subject N of approximately 5000.[2] Furthermore, we reviewed and published data on half-a-dozen recent surveys, including the National Health Examination.[3]

The basic questions were twofold. First, we were concerned with whether black-white hemoglobin differences (such as we had observed in Michigan) were replicated in the remaining ten states, in the Pre-School Nutrition Survey, and in the other surveys mentioned. Second, we were concerned with ascertaining whether the black-white differences in hemoglobin levels were simply the product of socio-economic factors (and purely environmental in nature) or whether they were fundamental differences between blacks and whites, and of major medical and nutritional importance.

We have, furthermore, conducted additional studies in attempts to resolve the problem. Such studies have involved matched-comparisons of blacks and whites with high reported levels of iron intake, comparisons of higher-income groups, and comparisons of black and white athletes with expectably higher hemoglobin levels.[4]

FINDINGS

As shown in the first table, where hemoglobin data are given by age, median hemoglobin levels are systematically lower in black individuals. This is true at each of 24 age groups (from the first year through the 9th decade, without exception). The black-white differences in hemoglobin levels also hold for both sexes, without exception. These differences, shown in the first table, are highly significant both by individual "t" tests and by tests for trend. Thus, in a total of 27,900 subjects, using median values of hemoglobin to eliminate errors due to skewness, there is a systematic difference approximating 1.0gm/100ml. This systematic difference in hemoglobin level is fully evident even during the period of rapid adolescent gain in hemoglobin levels in the male, and during the period of declining hemoglobin levels in the 7th and 8th decades. Black-white differences in hemoglobin levels, given in detail in the table, are shown graphically in Figure 1. For 11,178 males (above) and 14,991 females (below) the systematic nature and relatively great magnitude of the black-white differences in hemoglobin levels are impressive indeed.[5,6]

Now the blacks and the whites in the 10-State Nutrition Survey, those selected on a lower-income basis, were not matched with respect to income, per-capita income or income relative to needs, since a much larger proportion of black individuals in the United States are at or below the poverty level than is true of whites. Accordingly, therefore, we set up matched-income groupings with comparable income limits comparing low-income blacks with with low-income whites, and median-income blacks with median-income whites. On a per-capita income basis, the low-income groupings included individuals with

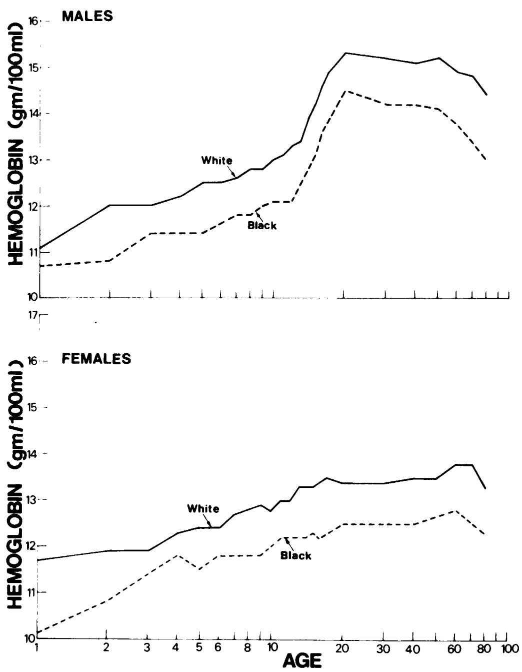

Fig. 1. Life-long differences in hemoglobin levels between blacks (dashed line) and whites (solid line), as shown in 27,900 participants in the Ten-State Nutrition survey of 1968-1970. Overall, black-white differences in hemoglobin approximated 1.0gm/100ml. in both males (above) and females (below), and at each of 24 ages from the first year through the 9th decade.

per-capita income up to $799 per year (and an income-to-needs ratio of 1.0), while the median-income groupings included individuals with per-capita incomes of $2400 and up per year (approximating an income-to-needs ratio of 3.0 and averaging close to median USA incomes for years 1968-1970). However, as shown in Table 2 and as depicted in Fig. 2, correction for income and per-capita income did not eliminate or substantially alter the black-white differences in hemoglobin levels. Both for the low-income (below poverty) grouping and for the median-income ($2400 and up) grouping, black-white differences in hemoglobin levels still average closer to 1.0gm/100ml. As shown in the second table and as graphed in the second figure, income-matched black-white hemoglobin differences closely approximated, in magnitude and pattern, differences previously observed in the total sample of nearly 30,000 individuals.

Now the blacks and the whites in the 10-State Nutrition Survey did not represent identi-

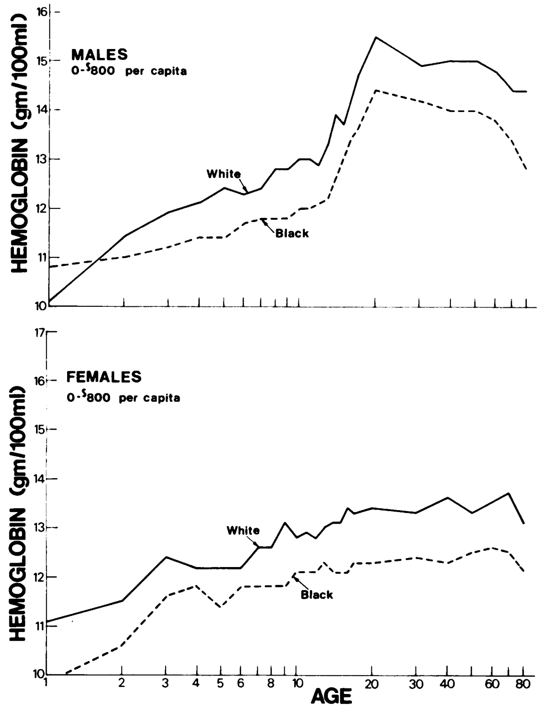

Fig. 2. Black-white differences in hemoglobin levels for blacks and whites matched for income level. Both for the below-poverty grouping shown in the graph and for blacks and whites with per-capita incomes in excess of $2,400 per year, life-long differences in hemoglobin level continue to approximate 1.0gm/100ml. in both sexes and in 47 out of 48 age-specific comparisons.

cal geographical selections. A disproportionate number of blacks came from Louisiana, South Carolina and Texas, and a disproportionate number of whites were derived from Washington State. Accordingly, close comparison was made of blacks and whites in several northern and northeastern states where there was approximately equal representation and where the populations were primarily urban in nature. As shown in Figure 3, for the State of Michigan, comparisons on a single-state basis are virtually identical with those for the 10-state sample as a whole and for income-

TABLE 2. BLACK-WHITE HEMOGLOBIN DIFFERENCES IN INCOME-MATCHED GROUPS

	*Below-Poverty Group**								*Median-Income Group***							
	Males				*Females*				*Males*				*Females*			
	Black		*White*		*Black*		*White*		*Black*		*White*		*Black*		*White*	
Age	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*	*N*	*Mdn*
1	62	10.8	18	10.1	41	9.8	14	11.1	19	10.1	14	11.4	21	10.2	14	11.8
2	70	11.0	26	11.4	97	10.6	29	11.5	26	10.5	16	12.2	29	10.8	27	11.9
3	103	11.2	29	11.9	86	11.6	26	12.4	29	11.3	37	12.0	27	11.1	21	11.5
4	136	11.4	41	12.1	102	11.8	47	12.2	34	10.8	40	12.2	29	11.4	28	12.1
5	134	11.4	55	12.4	139	11.4	55	12.2	36	11.4	42	12.3	30	11.8	26	13.2
6	160	11.7	64	12.3	145	11.8	64	12.2	40	11.1	39	12.5	34	11.5	32	12.5
7	137	11.8	72	12.4	185	11.8	75	12.6	41	11.8	68	12.4	50	11.5	31	12.7
8	147	11.8	77	12.8	159	11.8	60	12.6	43	11.8	50	12.8	39	11.8	50	12.6
9	164	11.8	68	12.8	161	11.8	73	13.1	43	12.0	59	12.9	51	11.8	62	12.7
10	139	12.0	82	13.0	178	12.1	85	12.8	58	12.1	63	12.9	51	11.9	55	12.9
11	140	12.0	75	13.0	171	12.1	80	12.9	39	12.5	55	13.2	47	11.8	50	12.8
12	173	12.1	69	12.9	167	12.1	63	12.8	40	12.1	64	13.2	41	12.1	54	13.3
13	136	12.2	65	13.3	166	12.3	52	13.0	40	12.5	54	13.1	41	11.9	65	13.4
14	133	12.6	54	13.9	145	12.1	45	13.1	45	12.8	53	14.0	38	11.8	48	13.3
15	122	13.0	31	13.7	129	12.1	47	13.1	35	13.2	50	14.1	42	12.1	35	13.3
16	97	13.4	34	14.2	121	12.1	49	13.4	38	13.7	46	14.6	45	12.2	49	13.4
17	78	13.6	14	14.7	89	12.3	32	13.3	16	13.1	49	14.8	28	11.8	45	13.7
20	125	14.4	67	15.5	330	12.3	128	13.4	84	14.6	232	15.3	120	12.2	318	13.4
30	77	14.2	55	14.9	372	12.4	189	13.3	77	14.6	318	15.3	148	12.5	376	13.3
40	90	14.0	80	15.0	379	12.3	187	13.6	70	14.2	214	15.2	136	12.5	276	13.5
50	97	14.0	62	15.0	248	12.5	132	13.3	69	14.3	288	15.2	170	12.8	424	13.6
60	103	13.8	94	14.8	204	12.6	122	13.5	78	13.4	298	14.9	125	12.7	369	13.8
70	98	13.4	89	14.4	162	12.5	124	13.7	33	13.2	171	14.9	59	12.7	220	13.8
80	36	12.8	38	14.4	47	12.1	46	13.1	11	12.9	61	14.5	17	12.5	78	13.5
Mean Difference				-0.9gm/100ml				-0.9gm/100ml				-1.1gm/100ml				-1.1gm/100ml

*Per-capita income below $799.
**Per-capita income $2400 up.

matched groupings both poor and rich.

Specific investigations were also undertaken to ascertain the possible effects of differences in iron intake on hemoglobin levels. However, restricting the study to girls with high reported levels of iron intake, hemoglobin differences were then virtually the same (1.0gm/100ml) as in the sample as a whole.[6] In addition, we have had the opportunity to explore hemoglobin levels in black and white athletes from the state of Washington. There, in a relatively small sample, black-white differences in hemoglobin levels were in the direction previously described, but of a much smaller magnitude.[4]

We have data, moreover, indicating that black-white differences in hemoglobin levels are present in young infants and even at birth. Limited data from the National Collaborative Project of the Perinatal Research Branch of the National Institute of Neurological Diseases and Stroke, cited to us by Dr. Janet Hardy at Johns Hopkins Hospital, confirm such a difference. Moreover, we have recently investigated black-white differences in neonates in the University of Washington Hospital and find that (with adequate attention to transferrin concentrations) there is a difference in hemoglobin level approximating 0.5gm/100ml, even in the first few days of life (Fig. 4).

We have examined reported hemoglobin findings from a variety of surveys of recent nature, including the National Health Examination,[3] and several regional surveys.[7,8] Though the data are not presented on an age-by-age basis as in Tables 1 and 2, and the nature of the samples differ radically, the direction and indeed the magnitude of the differences are very close to those shown in the earlier tables and graphs. Whether in the 10-State Nutrition Survey, the Pre-School Nutrition Survey, in the National Health Examination, or in various regional surveys there are considerable black-white differences in hemoglobin levels expressed as gm/100ml, and neither the direction not the magnitude of the differences is altered by corrections for economic level, geographical area, state of origin or level of iron intake.

DISCUSSION

In the course of our investigations, involving more than 40,000 men, women, and children, we have found a hemoglobin difference between blacks and whites that approximates 1gm/100ml. This hemoglobin difference is usefully large, by clinical standards it is highly significant at each age interval from one through 85, and it is consistent for both sexes. We have excluded the possibility that the hemoglobin difference is an accident of

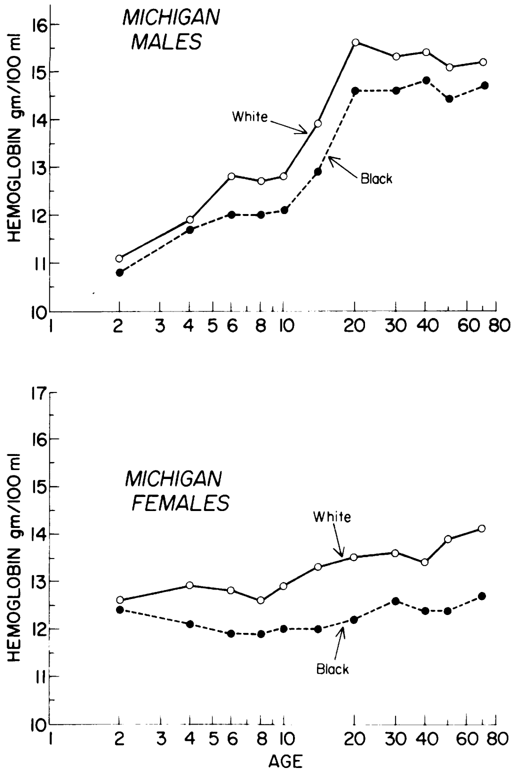

Fig. 3. Black-white differences in hemoglobin levels for 937 whites and 862 blacks in the state of Michigan. In this comparison with hemoglobins determined by a single, central laboratory and with geographic and climatic variables minimized, black-white differences in hemoglobin level continue to approximate 1.0gm/100ml in both sexes.

sampling by the very large sample size, by the remarkably systematic nature of the difference at each age-interval employed, and by careful comparisons in those states where comparable numbers of blacks and whites were included in the study.

Similar differences exist in the hematocrits for the same black and white subjects compared, indicating that the difference lies in packed-cell volume, and (presumably) in the red-cell volume. Since the difference between blacks and whites is repeated in the hemoglobins and the hematocrits, but not the MCMH ratio, it can be argued that the difference is not a simple reflection of iron intake and utilization. Indeed, for individuals selected on the basis of high reported levels of iron intake, black-white differences are still of the order of 1gm/100ml. Studies of athletes, who tend to higher hemoglobins and hematocrits, still show evidence of differences

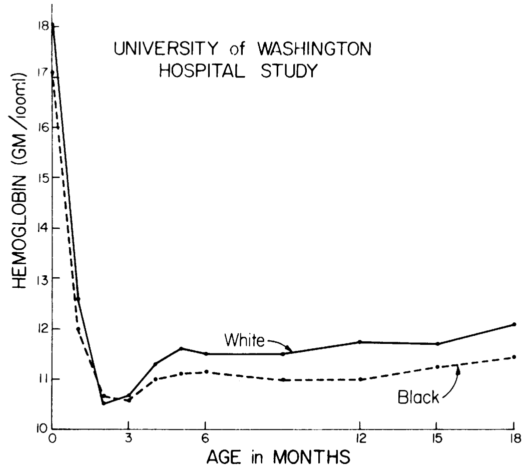

Fig. 4. Hemoglobin differences between 39 black infants (solid line) and 32 white infants (dashed line), followed from birth through 18 months af age, and maintained on a supervised dietary with iron in excess of recommended dietary allowances.

between blacks and whites, though not necessarily of the order of 1gm/100ml.

We have attempted to minimize the black-white hemoglobin differences by careful attention to socio-economic status (using per-capita income and the income-to-needs ratio, or "index of poverty"). Both at low incomes, however, below the poverty line and at higher incomes (approximating the median per-capita income for all Americans), black-white differences in hemoglobins still approach 1gm/100ml. Family-income, per-capita income or income related to needs does not "explain" the black-white differences in hemoglobin levels that we have observed and that may be observed in other survey data north, south and nationwide.

There are two possible explanations for the black-white differences in hemoglobin levels reported here, and which are evident in other survey results. The first is a *genetic* explanation. If correct, this would imply that blacks have lower hemoglobin levels even among those economically favored, and it would suggest the need for separate hemoglobin standards for blacks different from those in current clinical use. If correct, the "genetic" explanation would also raise the possibility of mechanisms for oxygen transport beyond those provided by the respiratory pigments.

The second explanation is a purely environmental explanation. If correct, it would suggest that there are differences in the way of life and the choice and preparation of foods that transcend socio-economic status, and so result in lower hemoglobins and hematocrits in blacks as compared with whites of equal incomes. We have given careful consideration to this possibility, since our data also indicate that urinary ascorbic acid and urinary riboflavin levels are lower in blacks than in whites of comparable per-capita incomes.

The resolution to this problem is investigative rather than literary, and is to be conducted in orphanages, in military units, and in cross-racial adoptions. One looks to bi-racial orphanages, atomic submarines and families with cross-racial adoptions for situations where black-white hemoglobin levels can be best compared.

Meanwhile, however, the rather large lgm/100ml difference in hemoglobin levels between blacks and whites remains a difference to be considered whenever hemoglobin values are taken into consideration.

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ACKNOWLEDGEMENTS

These studies were supported by subcontracts from Contract HSM 21/71-520 and Contract HSM 2/71-526 to the American Academy of Pediatrics and Contract NIH 74-C-1114-CC with NICHD, National Institutes of Health. We appreciate the assistance of Miss Dixie L. Farquharson in the manuscript completion.

FAMILY PRACTICE HOTLINE SERVICE FOR RESIDENCIES

Graduating medical students seeking to enter family practice residencies in July but who are unable to get the residency slot they want through the National Intern/Resident Matching Program (NIRMP) now can get a second chance. They can call the "family practice hotline" service set up by the Education Division of the American Academy of Family Physicians in Kansas City, Mo. The Academy is the national association of family doctors.

The "f.p. hotline" is a national "residency information brokerage" that uses the long distance lines to put students in touch with residency directors with openings in their programs. The simple reason for the "hotline" is that there are 2,200 U.S. medical students graduating in June who will be trying for 1,600 slots family practice listed through NIRMP. There are about 200 or more slots that were not listed in the NIRMP match. This disparity resulted from residency programs approved too late to plan participation in the match, or from programs which have expanded their number of spaces since the fall deadline.

This will be the second year the "hotline" has operated. Last year, more than 250 calls were received in a 7-day period, resulting in placement of more than 100 students in family practice residencies. The total number of approved 3-year family practice residencies now is more than 220. These residencies are in teaching hospitals and university medical centers throughout the U.S.

The American Board of Family Practice now has some 7,000 diplomates (including a practice-eligible group from the ranks of practitioners judged qualified to take the 2-day examination). After 1978, only residency-qualified candidates may be certified. ABFP also is the only certifying board that requires recertification. The mandate is for recertification every six years. The first class of diplomates (1970) are due to take the recertification examination in 1976.